(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 May 2003 (15.05.2003)

PCT

(10) International Publication Number
WO 03/040990 A2

(51) International Patent Classification[7]: G06F 19/00

(21) International Application Number: PCT/US02/35378

(22) International Filing Date:
4 November 2002 (04.11.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/335,542 2 November 2001 (02.11.2001) US

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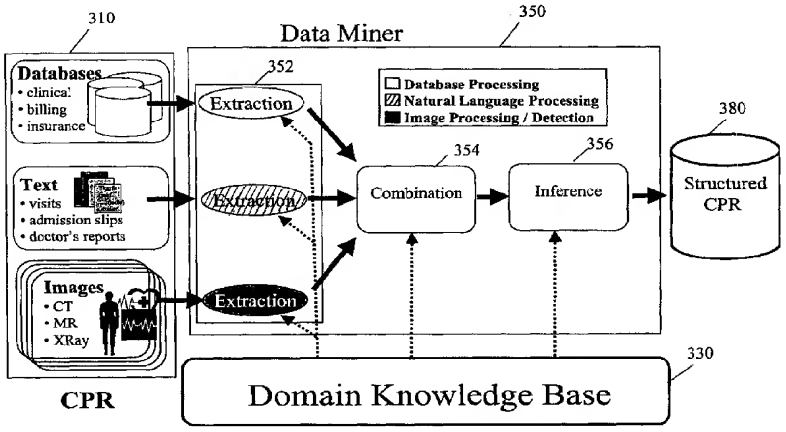
(81) Designated States *(national)*: CA, CN, JP.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: PATIENT DATA MINING FOR QUALITY ADHERENCE



(57) Abstract: The present invention provides systems and methods for automatically ensuring adherence to clinical guidelines during the course of patient treatments. A data source (202)contains patient records, including records for patients being treated; a guidelines knowledge base (204) contains clinical guidelines; and a quality adherence engine (206) is configured to monitor adherence with the clinical guidelines for patients being treated. At least some of the patient records may include information obtained from mining unstructured patient data. The system includes an output component (208) for outputting quality adherence information. The outputted quality adherence information may include reminders, including reminders to take clinical actions in accordance with the clinical guidelines. The outputted quality adherence information may also include warnings that the clinical guidelines have not been observed.

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PATIENT DATA MINING FOR QUALITY ADHERENCE

Cross Reference to Related Applications

This application claims the benefit of U.S. Provisional Application Serial No. 60/335,542, filed on November 2, 2001, which is incorporated by reference herein in its entirety.

Field of the Invention

The present invention relates to medical information processing systems, and, more particularly to a computerized system and method for providing quality adherence information for health care organizations.

Background of the Invention

Health care organizations are increasingly turning to evidence-based approaches to improve quality of care. For instance, health care organizations typically employ clinical guidelines that provide recommendations based on the best available medical scientific evidence. Health care quality can be measured by comparing clinical actions to guideline recommendations.

The results of such comparisons can be used by health care organizations to determine areas of excellence within their organizations as well as those areas that need

improvement. This information provides an objective basis for planning and making budgeting decisions. In addition, it may be used to demonstrate accountability to the public and back up claims of quality.

Currently, solutions that address the issue of quality of care usually only focus on retrospective comparisons with clinical guidelines. Although retrospective comparisons can provide valuable information, there are generally few mechanisms in place for ensuring adherence to guidelines during the course of patient treatment. Such information would be very useful in determining problems as they happen, so that corrective action could immediately be taken.

As health care organizations migrate toward environments where most aspects of patient care management are automated, it is now easier to collect and analyze patient information. However, health care organizations tend to maintain information in a myriad of unstructured and structured data sources. For example, it may be necessary to access numerous different databases, each with its own peculiar format. Worse, physician notes may have to be consulted. These notes usually are nothing more than free text dictations, and it may be very difficult to sift through the notes to gather the necessary information. As a result, the effort taken to collect information is usually time consuming, expensive, and error prone.

Given the importance of providing quality of care information, it would be desirable and highly advantageous to generate accurate quality adherence information during the course of patient treatment.

Summary of the Invention

The present invention provides a technique for generating accurate quality adherence information during the course of patient treatment.

In various embodiments of the present invention, a system is provided that includes a data source containing patient records, including records for patients being treated; a guidelines knowledge base containing clinical guidelines; and a quality adherence engine for monitoring adherence with the clinical guidelines for the patients being treated. At least some of the patient records may include information obtained from mining unstructured patient data.

The system includes an output component for outputting quality adherence information. The outputted quality adherence information may include reminders, including reminders to take clinical actions in accordance with the clinical guidelines. The outputted quality adherence information may also include warnings that the clinical guidelines have not been observed.

The quality adherence engine may be configured to

monitor adherence to the clinical guidelines by comparing clinical actions with clinical guidelines. The clinical guidelines can relate to recommended clinical actions. The quality adherence engine can monitor adherence to the clinical guidelines by determining the next recommended clinical actions. Reminders for the next recommended clinical actions can be output so that health care providers are better able to follow the recommendations.

These and other aspects, features and advantages of the present invention will become apparent from the following detailed description of preferred embodiments, which is to be read in connection with the accompanying drawings.

Brief Description of the Drawings

FIG. 1 is a block diagram of a computer processing system to which the present invention may be applied according to an embodiment of the present invention;

FIG. 2 shows an exemplary quality assurance system in accordance with an embodiment of the present invention;

FIG. 3 shows an exemplary data mining framework for mining structured clinical information; and

FIG. 4 shows a flow diagram outlining an exemplary technique for automatically ensuring adherence to clinical guidelines during the course of patient treatments.

Description of Preferred Embodiments

To facilitate a clear understanding of the present invention, illustrative examples are provided herein which describe certain aspects of the invention. However, it is to be appreciated that these illustrations are not meant to limit the scope of the invention, and are provided herein to illustrate certain concepts associated with the invention.

It is also to be understood that the present invention may be implemented in various forms of hardware, software, firmware, special purpose processors, or a combination thereof. Preferably, the present invention is implemented in software as a program tangibly embodied on a program storage device. The program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units (CPU), a random access memory (RAM), and input/output (I/O) interface(s). The computer platform also includes an operating system and microinstruction code. The various processes and functions described herein may either be part of the microinstruction code or part of the program (or combination thereof) which is executed via the operating system. In addition, various other peripheral devices may be connected to the computer platform such as an additional data storage device and a printing device.

It is to be understood that, because some of the constituent system components and method steps depicted in the accompanying figures are preferably implemented in software, the actual connections between the system components (or the process steps) may differ depending upon the manner in which the present invention is programmed.

FIG. 1 is a block diagram of a computer processing system 100 to which the present invention may be applied according to an embodiment of the present invention. The system 100 includes at least one processor (hereinafter processor) 102 operatively coupled to other components via a system bus 104. A read-only memory (ROM) 106, a random access memory (RAM) 108, an I/O interface 110, a network interface 112, and external storage 114 are operatively coupled to the system bus 104. Various peripheral devices such as, for example, a display device, a disk storage device(e.g., a magnetic or optical disk storage device), a keyboard, and a mouse, may be operatively coupled to the system bus 104 by the I/O interface 110 or the network interface 112.

The computer system 100 may be a standalone system or be linked to a network via the network interface 112. The network interface 112 may be a hard-wired interface. However, in various exemplary embodiments, the network interface 112 can include any device suitable to transmit information to and from another device, such as a universal asynchronous receiver/transmitter (UART), a parallel digital interface, a

software interface or any combination of known or later developed software and hardware. The network interface may be linked to various types of networks, including a local area network (LAN), a wide area network (WAN), an intranet, a virtual private network (VPN), and the Internet.

The external storage 114 may be implemented using a database management system (DBMS) managed by the processor 102 and residing on a memory such as a hard disk. However, it should be appreciated that the external storage 114 may be implemented on one or more additional computer systems. For example, the external storage 114 may include a data warehouse system residing on a separate computer system.

Those skilled in the art will appreciate that other alternative computing environments may be used without departing from the spirit and scope of the present invention.

Referring to FIG. 2, an automated quality adherence system 200 is illustrated. The automated quality adherence system 200 includes a data source 202 containing patient records, a clinical guidelines knowledge base 204, a quality adherence engine 206, and an output component 208. The automated quality adherence system 200 is configured to monitor adherence with clinical guidelines for patients being treated.

Preferably, the data source 202 is organized as a structured clinical patient record (CPR) and populated with patient information using data mining techniques described in

"Patient Data Mining," by Rao et al., Attorney Docket No. 2001P20906US01, copending U.S. Patent Application Serial No. 10/___,___, filed herewith, which is incorporated by reference herein in its entirety.

As illustrates in FIG. 3, an exemplary data mining framework for mining high-quality structured clinical information includes a data miner 350 that mines information from a CPR 310 using domain-specific knowledge contained in a knowledge base 330. The data miner 350 includes components for extracting information from the CPR 352, combining all available evidence in a principled fashion over time 354, and drawing inferences from this combination process 356. The mined information may be stored in a structured CPR 380.

The extraction component 352 deals with gleaning small pieces of information from each data source regarding a patient, which are represented as probabilistic assertions about the patient at a particular time. These probabilistic assertions are called *elements*. The combination component 354 combines all the elements that refer to the same variable at the same time period to form one unified probabilistic assertion regarding that variable. These unified probabilistic assertions are called *factoids*. The inference component 356 deals with the combination of these factoids, at the same point in
time and/or at different points in time, to produce a coherent and concise picture of the progression of the patient's state

over time. This progression of the patient's state is called a *state sequence*.

Referring again to FIG. 2, the automated quality adherence system 200 can be configured to output quality adherence information, such as, for example reminders. The reminders may be generated to prompt physicians to take clinical actions in accordance with the clinical guidelines. The outputted quality adherence information may also include warnings that the clinical guidelines have not been observed.

The patient records contained in the data source 202 may include information regarding clinical actions taken during patient treatments. For example, the patient records may contain information regarding various tests and procedures administered to the patient.

The quality adherence engine 206 may be configured to monitor adherence to clinical guidelines by comparing clinical actions with the clinical guidelines. Since the clinical action information may be a product of inferences, it may therefore be probabilistic in nature. Thus, the warnings may be generated if there is a likelihood that the guidelines haven't been followed. Probability values may be assigned to each clinical action, and warnings issued if the probability that the guidelines weren't followed exceeds a predefined threshold.

The quality adherence engine 206 may also monitor adherence to clinical guidelines by determining the next

recommended clinical actions. Reminders for the next recommended clinical actions may be output so that health care personnel are better able to follow the recommendations.

For example, guidelines for treatment of acute myocardial infarction (AMI) promulgated by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) call for certain AMI patients without aspirin contraindication to receive aspirin within 24 hours before or after hospital arrival. In this case, the quality adherence engine 206 can select patient records for AMI patients from the data source 202, and generate a reminder that aspirin should be given to certain of those patients. If the 24 hour period expired without aspirin being provided to an AMI patient, then a warning may instead be outputted.

The output component 208 may output these reminders and warnings, as the case may be, along with other quality adherence information. The output component 208 may be implemented to output this information via a printed report, a computer display device, etc. However, in various other embodiments, the quality adherence information may be integrated into a physician calendar/scheduling system.

Referring to FIG. 4, a flow diagram outlining an exemplary technique for automatically ensuring adherence to clinical guidelines during the course of patient treatments is illustrated. Beginning at step 402, patient records are obtained from a data source. At least some of the obtained

patient records may contain treatment information derived from unstructured information, such as, for example, physician notes, medical images, and waveform information. Preferably, this information resides in a structured data repository populated using mined unstructured patient information, as described in "Patient Data Mining," by Rao et al., Attorney Docket No. 2001P20906US01, copending U.S. Patent Application Serial No. 10/___,___,.

In step 404, clinical guidelines are retrieved from a clinical guidelines knowledge base. For example, the clinical guidelines may be stored in a database, and contain recommended clinical actions for various diseases of interest. These clinical guidelines may include recommendations promulgated by accreditation organizations (such as JCAHO), government agencies, and consumer health care organizations. In addition, clinical guidelines may be created for internal use (e.g., by a hospital to measure quality of care). In general, clinical guidelines may include any list of recommended clinical actions.

Next, in step 406, adherence to the clinical guidelines are monitored. This may involve determining the current patient diagnosis, and comparing clinical actions taken with respect to the patient to relevant guidelines. If recommended clinical actions were not observed, warnings may be generated to physicians and other medical personnel. The recommended

next clinical actions for the patient may also be determined, and reminders may be generated.

In step 408, quality adherence information, such as the reminders and warnings, may be output via a report, a computer display, or even integrated into a calendar or scheduling system.

As shown in FIGs. 1-4, this invention is preferably implemented using a general purpose computer system. However the systems and methods of this invention can be implemented using any combination of one or more programmed general purpose computers, programmed microprocessors or micro-controllers and peripheral integrated circuit elements, ASIC or other integrated circuits, digital signal processors, hardwired electronic or logic circuits such as discrete element circuits, programmable logic devices such as a PLD, PLA, FPGA or PAL, or the like.

Although illustrative embodiments of the present invention have been described herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various other changes and modifications may be affected therein by one skilled in the art without departing from the scope or spirit of the invention.

WHAT IS CLAIMED IS:

1. A system for automatically ensuring adherence to clinical guidelines, comprising:

a data source containing patient records, including records for patients being treated;

a guidelines knowledge base containing clinical guidelines; and

a quality adherence engine for monitoring adherence with the clinical guidelines for the patients being treated.

2. The system of claim 1, wherein at least some of the patient records include information obtained from mining unstructured patient data.

3. The system of claim 1, further including an output component for outputting quality adherence information.

4. The system of claim 3, wherein the outputted quality adherence information includes reminders.

5. The system of claim 4, wherein the reminders include reminders to take clinical actions in accordance with the clinical guidelines.

6. The system of claim 3, wherein the outputted quality adherence information includes warnings that the clinical guidelines have not been observed.

7. The system of claim 3, wherein the outputted quality adherence information includes warnings that the clinical guidelines likely have not been observed.

8. The system of claim 1, wherein the patient records contained in the data source include information regarding clinical actions taken during patient treatments.

9. The system of claim 8, wherein the quality adherence engine monitors adherence to the clinical guidelines at least in part by comparing the clinical actions with the clinical guidelines.

10. The system of claim 9, wherein the clinical guidelines relate to recommended clinical actions.

11. The system of claim 10, wherein the quality adherence engine monitors adherence to the clinical guidelines at least in part by determining the next recommended clinical actions.

12. The system of claim 11, wherein the quality adherence engine monitors adherence to the clinical guidelines at least in part by outputting reminders for the next recommended clinical actions.

13. A method for automatically ensuring adherence to clinical guidelines during the course of patient treatments, comprising the steps of:

obtaining patient records for patients being treated, at least some of the patient records containing information from mined unstructured data sources;

retrieving clinical guidelines from a guidelines knowledge base; and

monitoring adherence to the clinical guidelines for the patients being treated.

14. The method of claim 13, further including the step of outputting quality adherence information.

15. The method of claim 14, wherein the outputted quality adherence information includes reminders.

16. The method of claim 15, wherein the reminders include reminders to take clinical actions in accordance with the clinical guidelines.

17. The method of claim 14, wherein the outputted quality adherence information includes warnings that the clinical guidelines have not been observed.

18. The method of claim 14, wherein the outputted quality adherence information includes warnings that the clinical guidelines have likely not been observed.

19. The method of claim 14, wherein the obtained patient records include clinical actions taken during the patient treatments.

20. The method of claim 19, wherein monitoring adherence to the clinical guidelines includes comparing the clinical actions with the clinical guidelines.

21. The method of claim 20, wherein the clinical guidelines relate to recommended clinical actions.

22. The method of claim 20, wherein monitoring adherence to the clinical guidelines further includes determining the next recommended clinical actions.

23. The method of claim 22, wherein monitoring adherence to the clinical guidelines further includes outputting reminders for the next recommended clinical actions.

24. A program storage device readable by a machine, tangibly embodying a program of instructions executable on the machine to perform method steps for automatically ensuring adherence to clinical guidelines, the method steps comprising:

obtaining patient records for patients being treated, at least some of the patient records containing information from mined unstructured data sources;

retrieving clinical guidelines from a guidelines knowledge base; and

monitoring adherence to the clinical guidelines for the patients being treated.

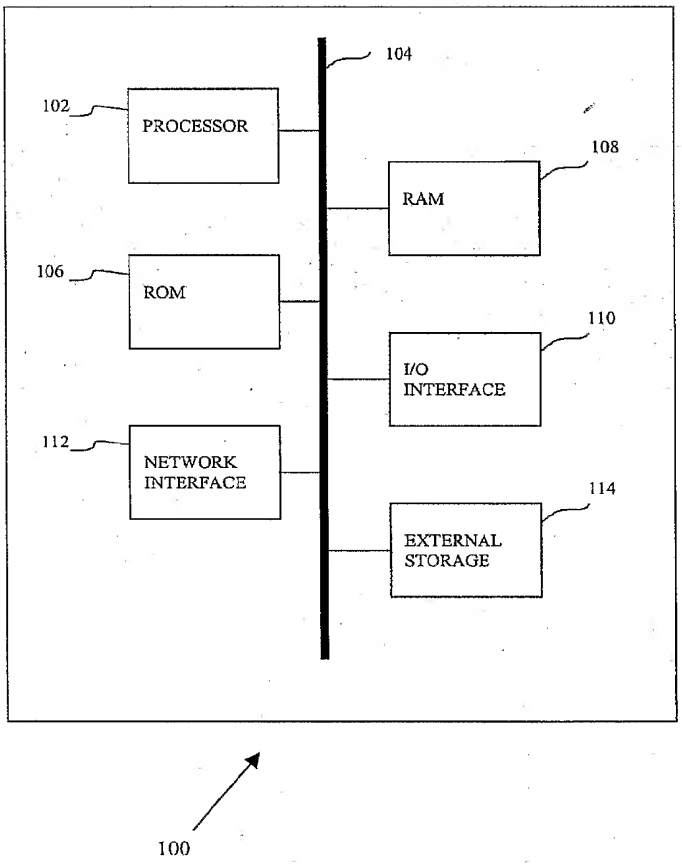
104
102
PROCESSOR
108
RAM
106
ROM
110
I/O
INTERFACE
112
NETWORK
INTERFACE
114
EXTERNAL
STORAGE
100

FIG. 1

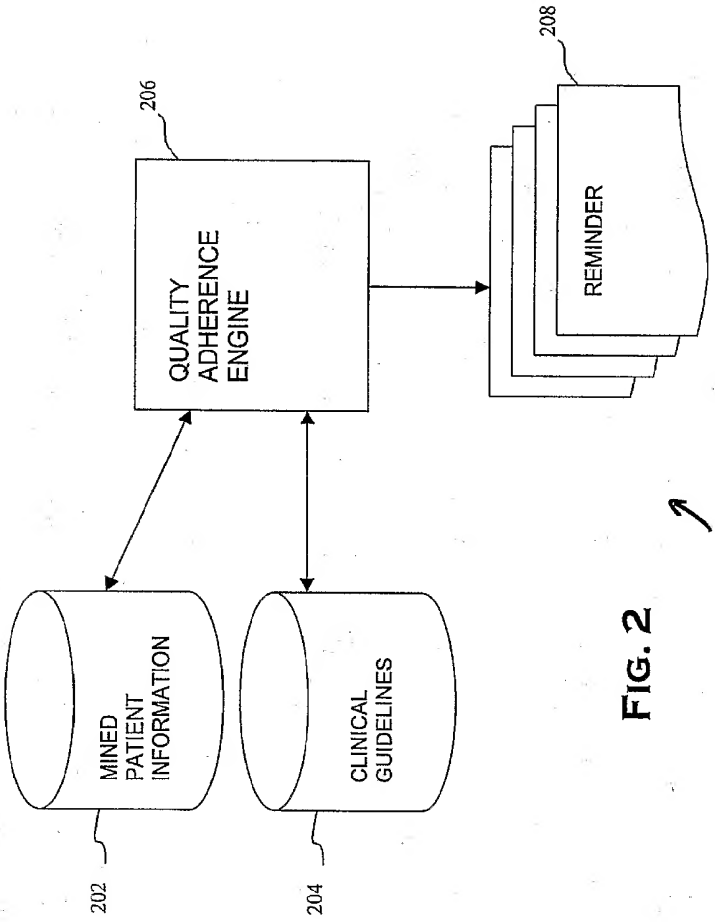
208
206
QUALITY ADHERENCE ENGINE
REMINDER
MINED PATIENT INFORMATION
CLINICAL GUIDELINES
202
204
200

FIG. 2

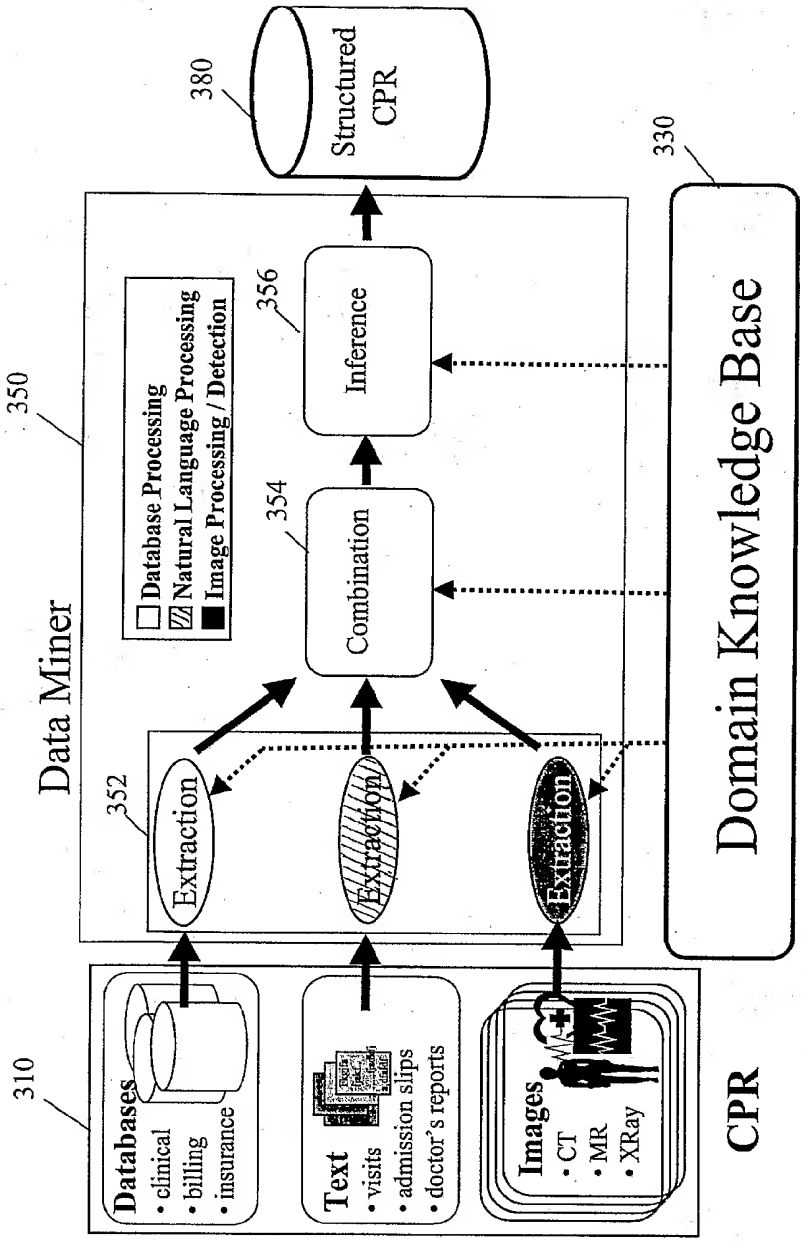
310
CPR
Databases
• clinical
• billing
• insurance
Text
• visits
• admission slips
• doctor's reports
Images
• CT
• MR
• XRay
350
Data Miner
352
Extraction
Extraction
Extraction
354
Combination
356
Inference
Database Processing
Natural Language Processing
Image Processing / Detection
330
Domain Knowledge Base
380
Structured CPR

FIG 3

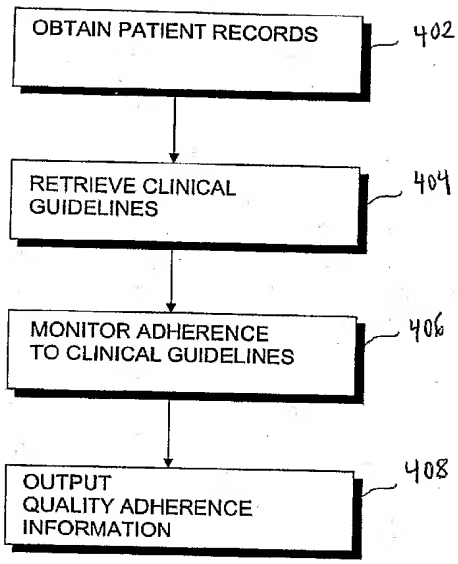
OBTAIN PATIENT RECORDS
402
RETRIEVE CLINICAL GUIDELINES
404
MONITOR ADHERENCE TO CLINICAL GUIDELINES
406
OUTPUT QUALITY ADHERENCE INFORMATION
408

FIG. 4